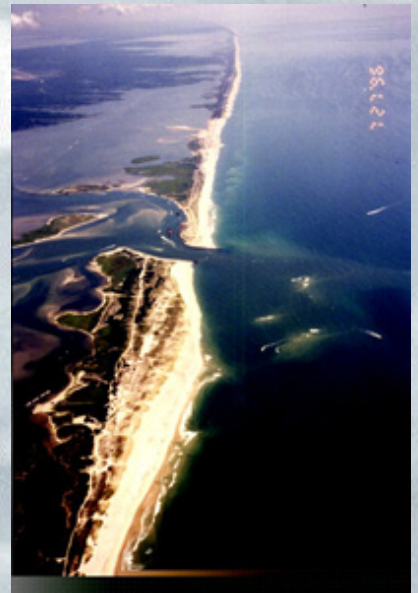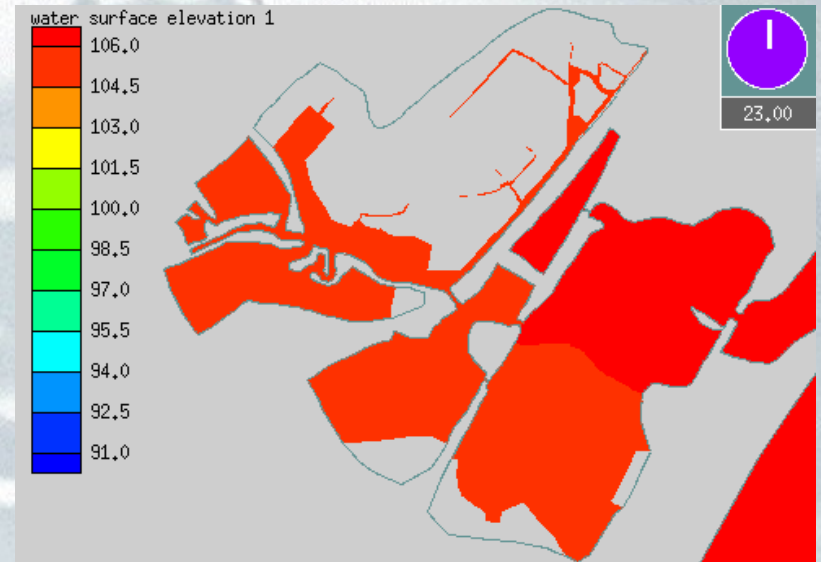# Two-Dimensional Flow Modeling & The Surface-Water Modeling System (SMS)

Mid-Western Hydraulics Engineers Conference
East Lansing, Michigan
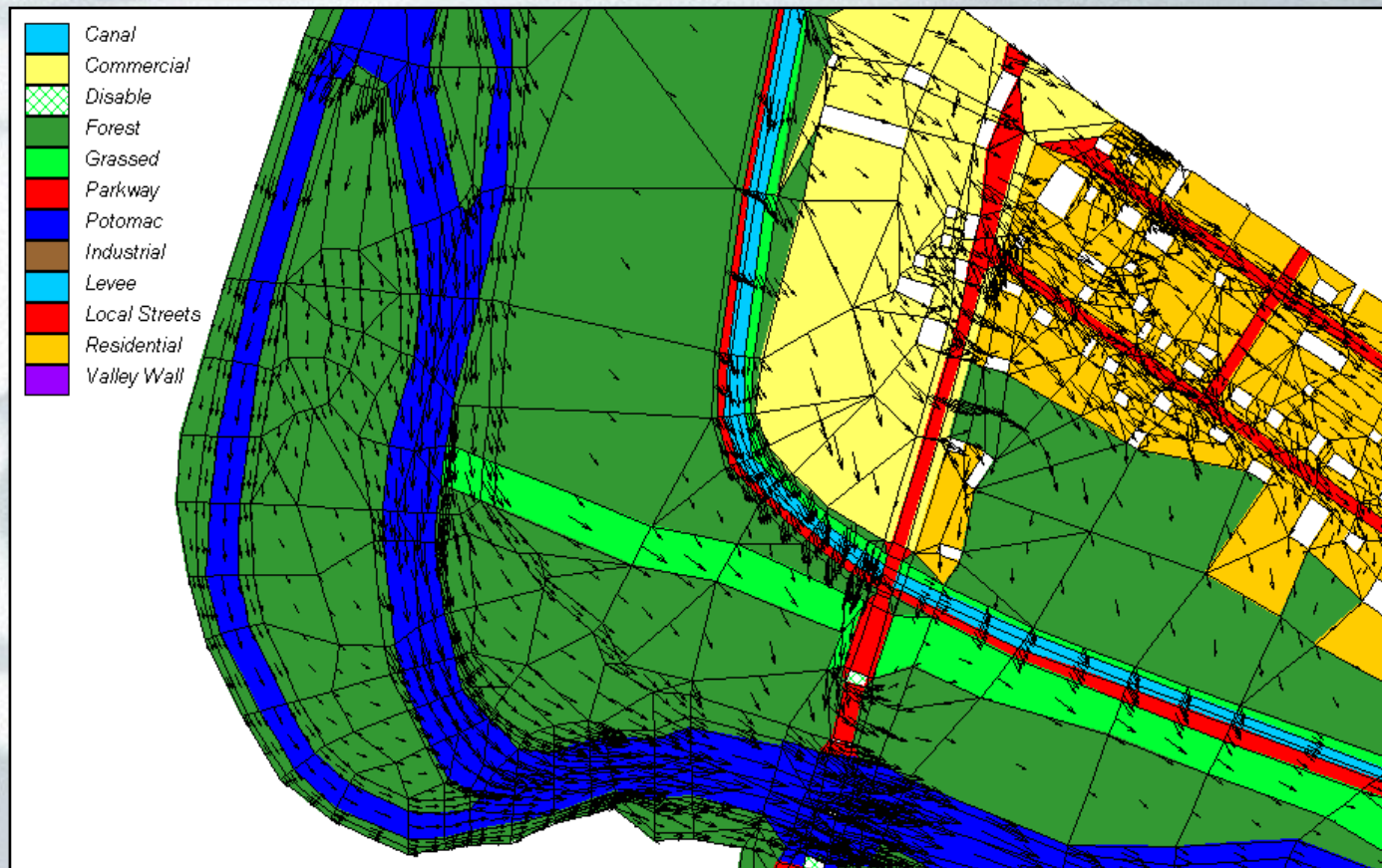August 26-28, 2003

SMS – 2D Numerical Applications

- Rivers
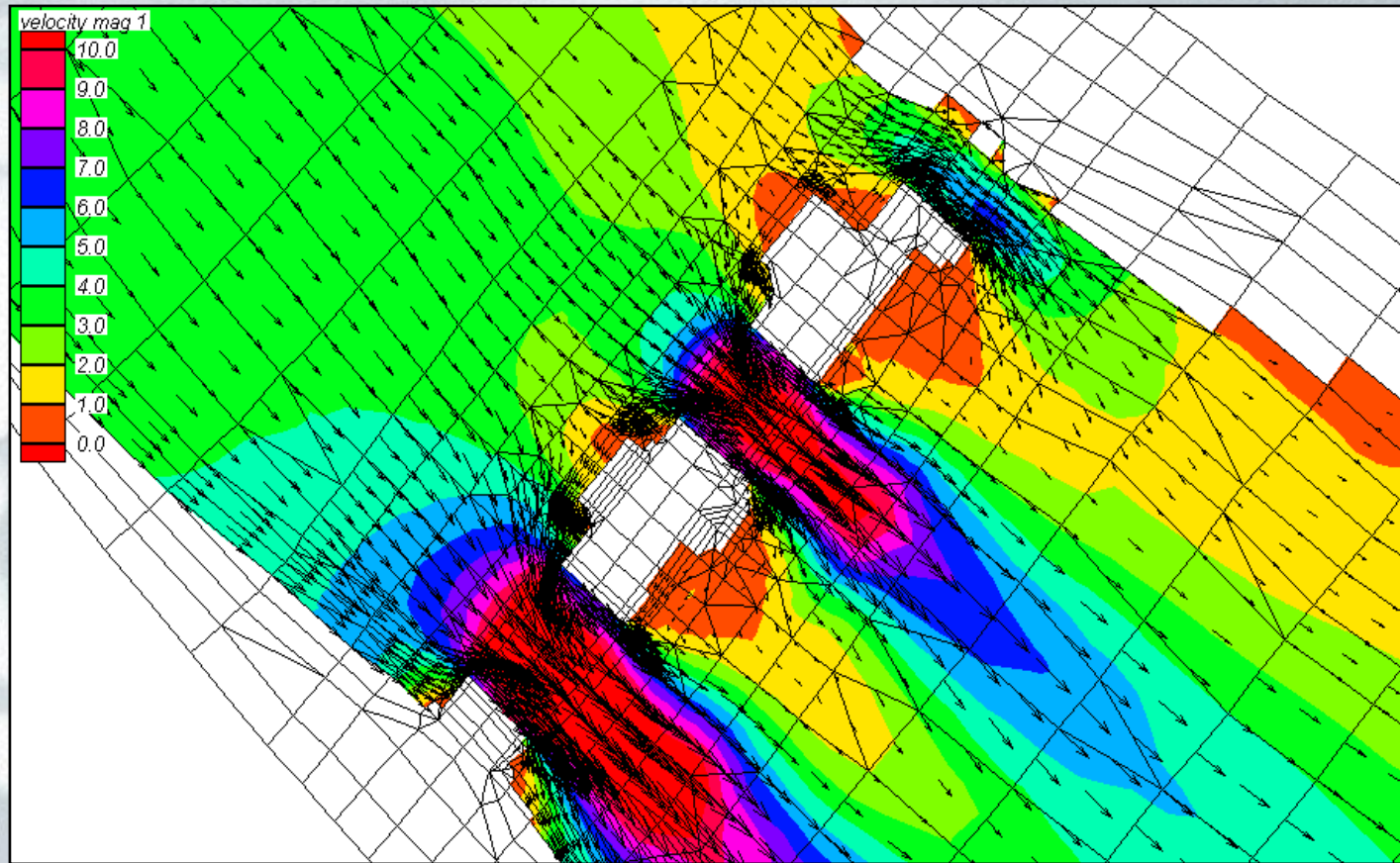- Estuaries/Bays
- Coastal Zones
- Theoretical Studies

Rivers

- Flooding – Inundation studies
- Bridge Crossings
- Velocity/Scour/Sedimentation
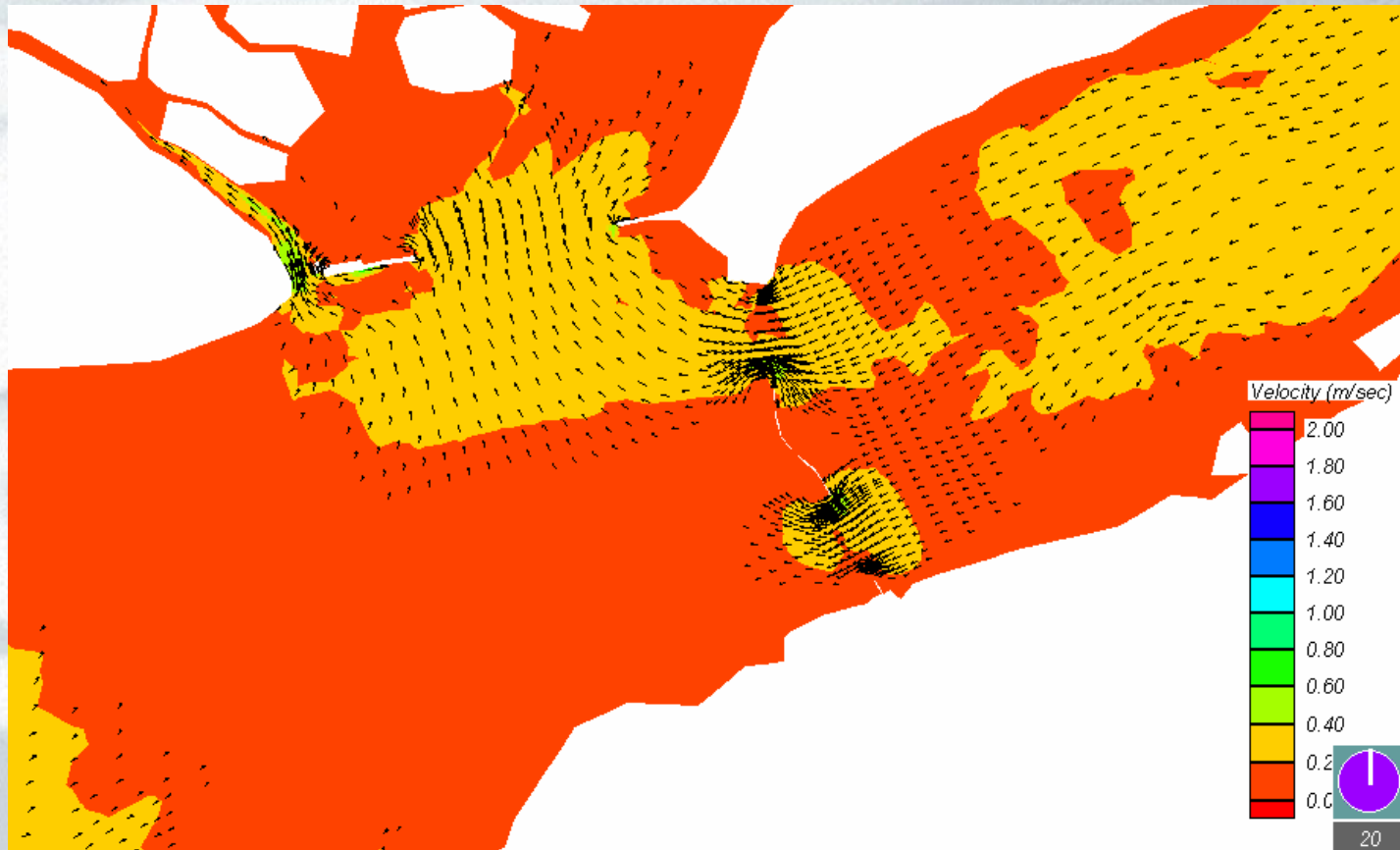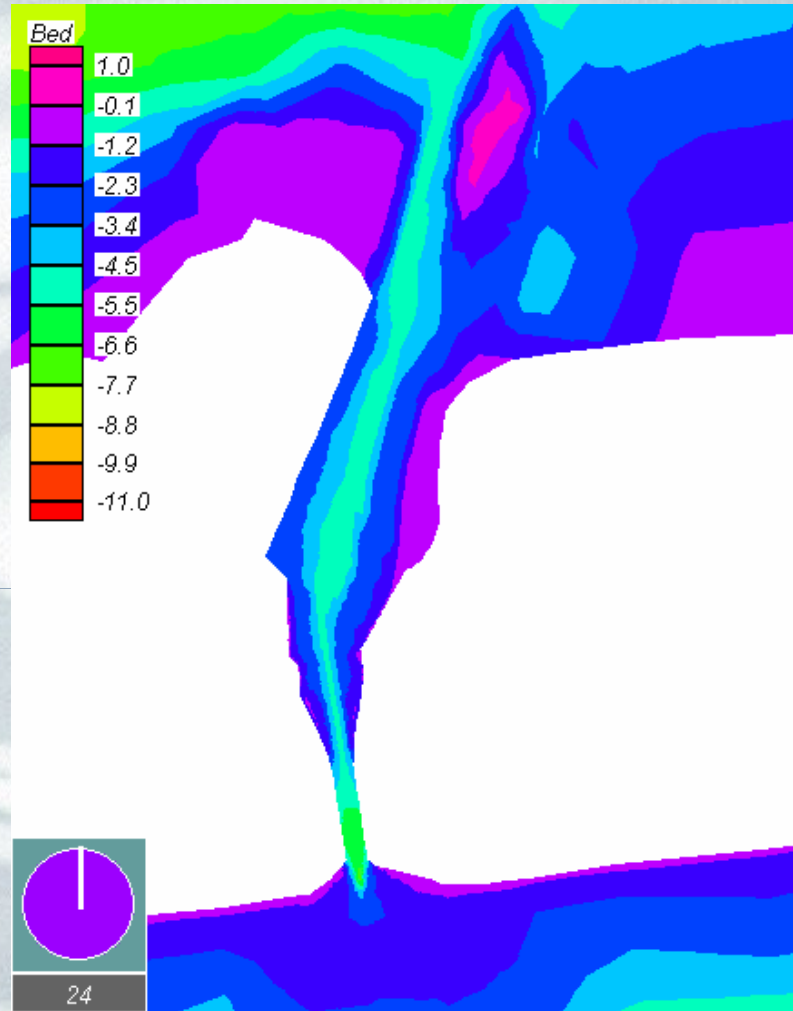- Flow Separations
- Navigation Studies

Floodplain Analysis

Legend:
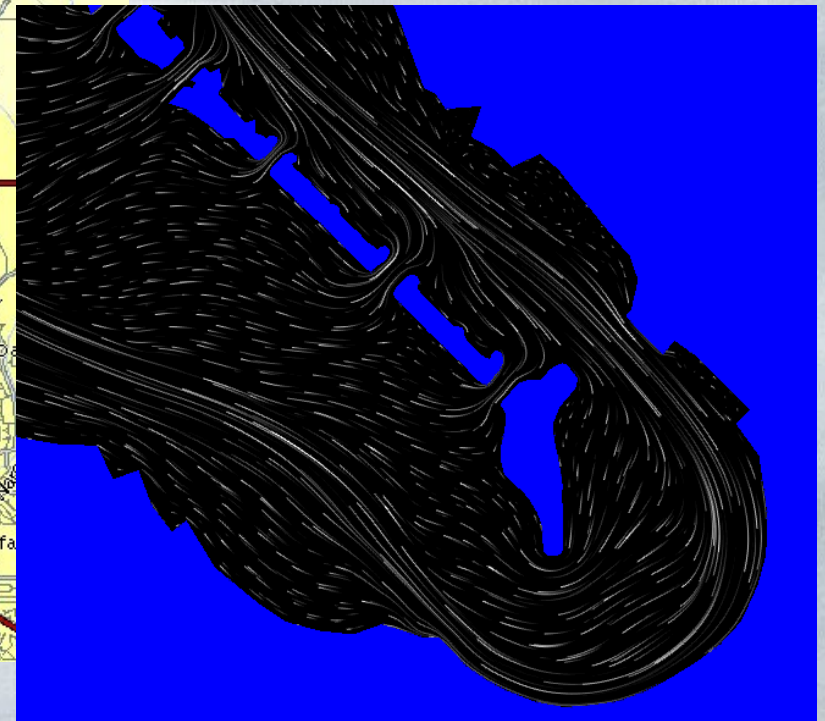- Canal
- Commercial
- Disable
- Forest
- Grassed
- Parkway
- Potomac
- Industrial
- Levee
- Local Streets
- Residential
- Valley Wall

Bridge Design

Dynamic Flow Analysis

Sediment Transport

Bridge Crossings – Interstate 65

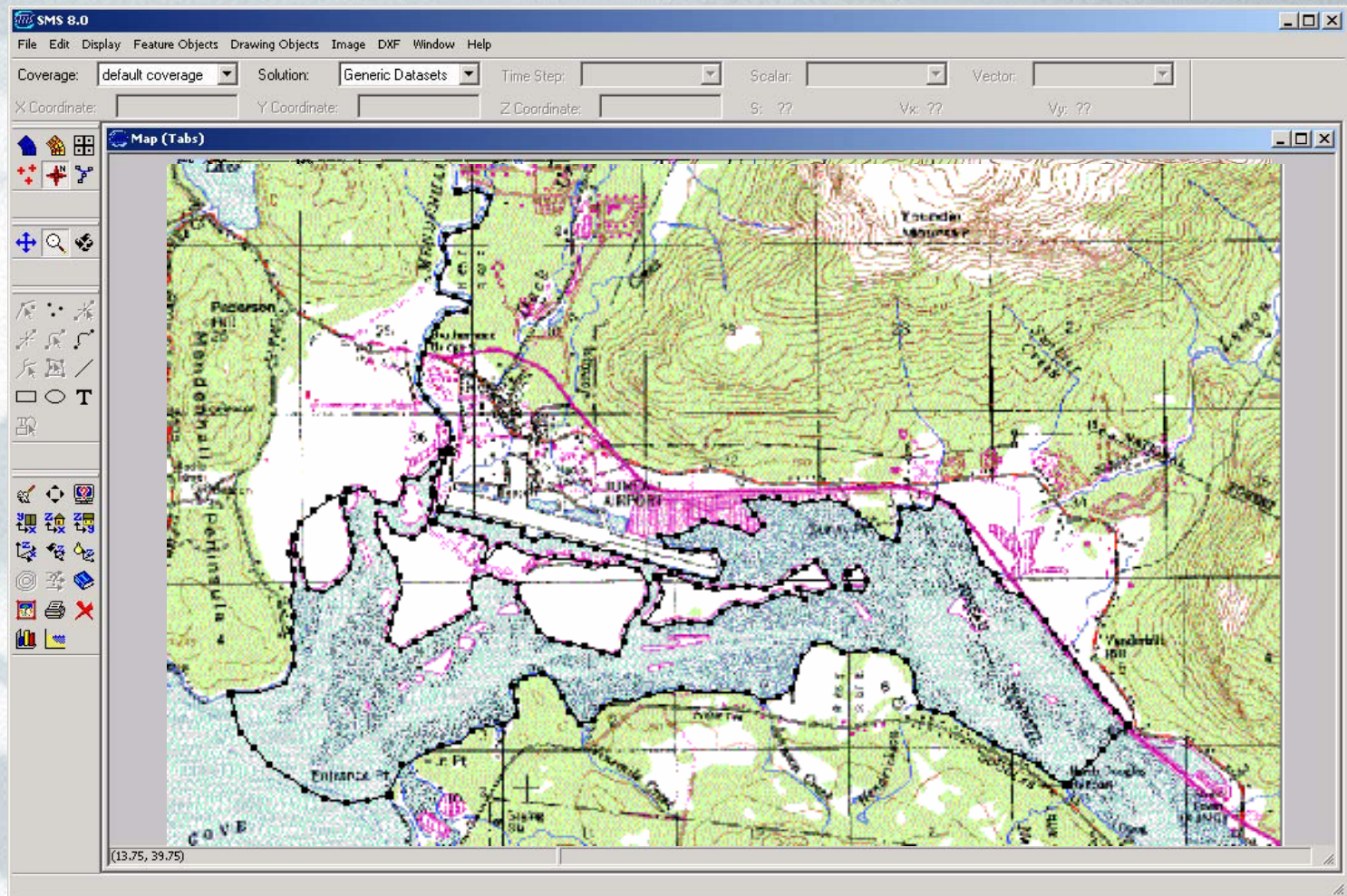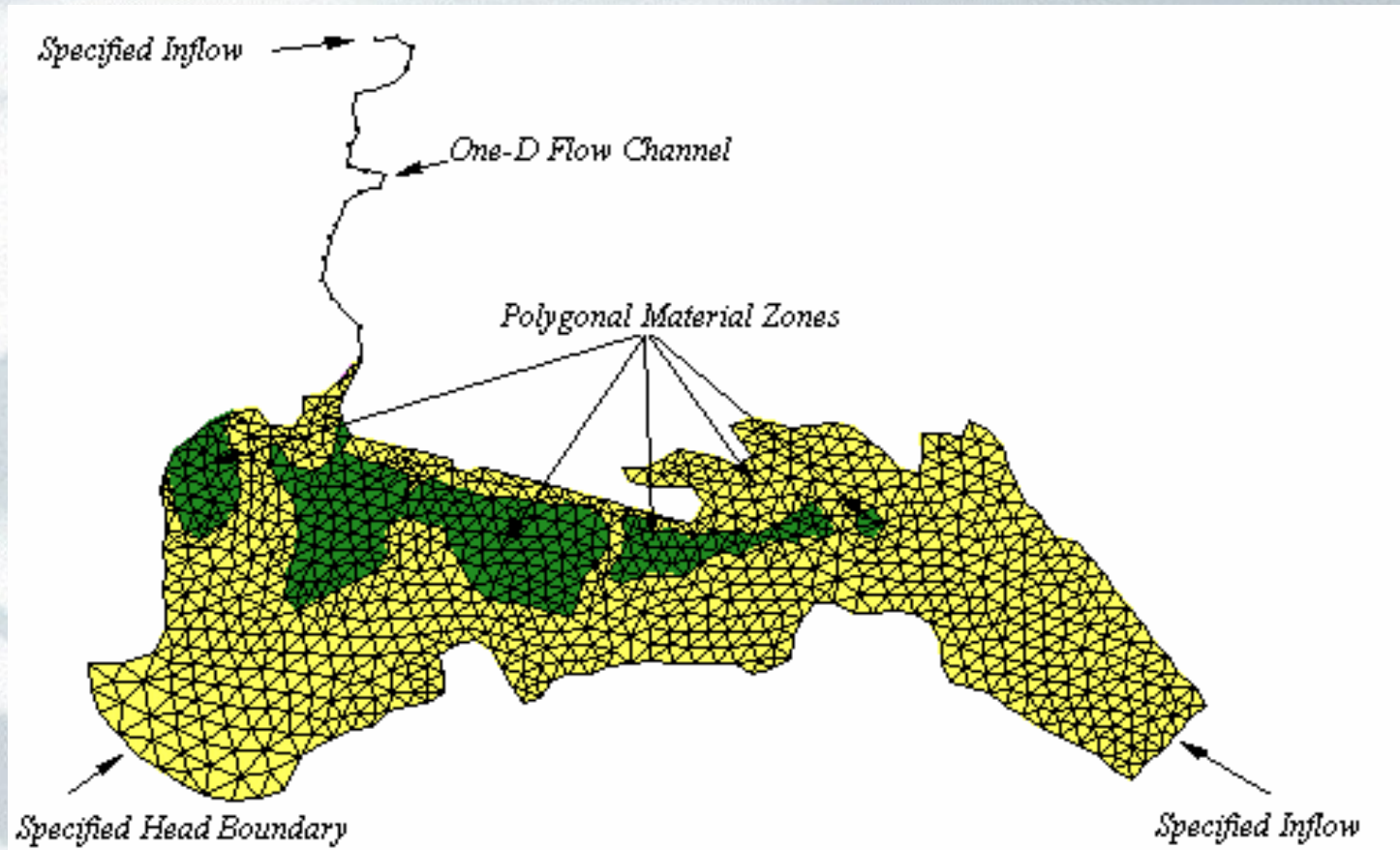# Flow Separations – Mississippi River

SMS Functional Modules

- Map Module
  - Background Images
  - Conceptual Model
- Scatter Point Module
  - Survey Data – Visualization and Filtering
- Mesh Module
  - Numerical Model – FESWMS/Flo2DH Data
- River Module
  - HEC-RAS Data

Map Module Data

Automatically Generated Mesh

Specified Inflow

One-D Flow Channel

Polygonal Material Zones

Specified Head Boundary

Specified Inflow

Flo2DH Interface – Model Control

- Simulation Comments
- Version
- Hydrodynamics/Sediment
- Steady State/Dynamic
- Output Options

Hydraulic Structures

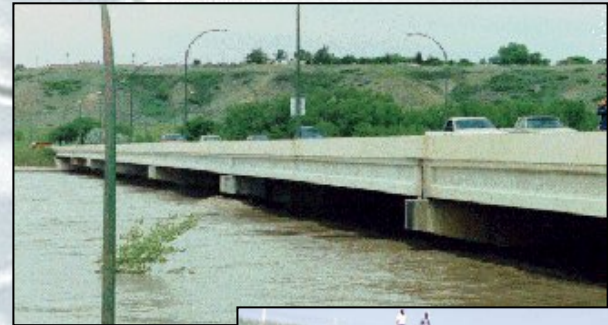Hydraulic structures that can be modeled with 2D modeling include the following:

- Bridges
- Culverts
- Weirs
- Roadway embankments
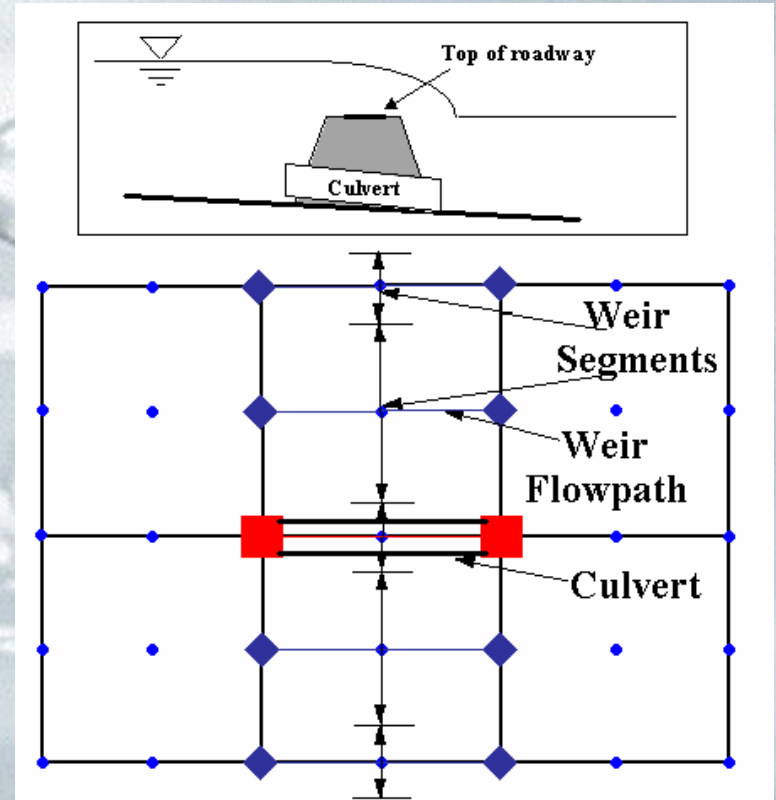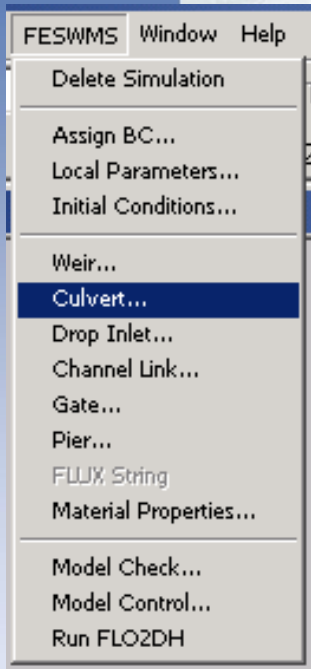- Drop-inlet spillways

1 Dimensional Flow Control

Several types of hydraulic structures can be modeled as one-dimensional links between node points:

- Weirs
- Culverts
- Gates
- Channel Links
- Drop-inlet spillways

1 Dimensional Flow Control

- Select the position in the network.
- Select the structure type from the menu

FESWMS   Window   Help

Delete Simulation

Assign BC...
Local Parameters...
Initial Conditions...

Weir...
Culvert...
Drop Inlet...
Channel Link...
Gate...
Pier...
FLUX String
Material Properties...

Model Check...
Model Control...
Run FLO2DH

1 Dimensional Flow Control

- Specify the structure characteristics

FESWMS Weir

Upstream node id 40
Downstream node id 54

Switch

Flap-gate

ID string:

Weir Coefficients

Weir type: Gravel roadway

Default discharge and submergence coefficients   Override

C_w - discharge: 0.544   ☑ 0.5
a-sub - submergence: 15.40   ☐ 0.0
b-sub - submergence: 0.608   ☐ 0.0

Weir Geometry

Lw - Crest length: 25
Zc - Crest elevation: 54
Minimum Head Difference: 0.0

○ Free Flow
○ Tailwater Elevation   0.0

Weir Description

Help   OK   Delete   Cancel

FESWMS Culvert

ID string: culvert
Comment:

Nodes
Upstream ID: 40
Downstream ID: 54

Switch

☐ Flap-gate

Type code: 1011
Material: Concrete
Shape: Circular
Inlet: Headwall, square edge

Inlet Control Flow Coefficients

Default values   Override defaults

K':   0.0098   ☑ 0.0098
M: 2.000   ☐ 0.0
c':   0.0398   ☑ 0.0398
Y: 0.670   ☐ 0.0
alpha: 1.040   ☐ 0.0

Number of barrels: 2
Entrance loss coefficient (ke):   0.2   Help
Manning roughness coefficient (nc):   0.015   Help
Rise (height):   50.0
Span (width):   48.0
Barrel length (Lc):   200.0
Invert elevation at upstream node: 226.0
Invert elevation at downstream node: 221.0
Tailwater elevation for outlet control: 0.0
Minimum head difference: 0.0
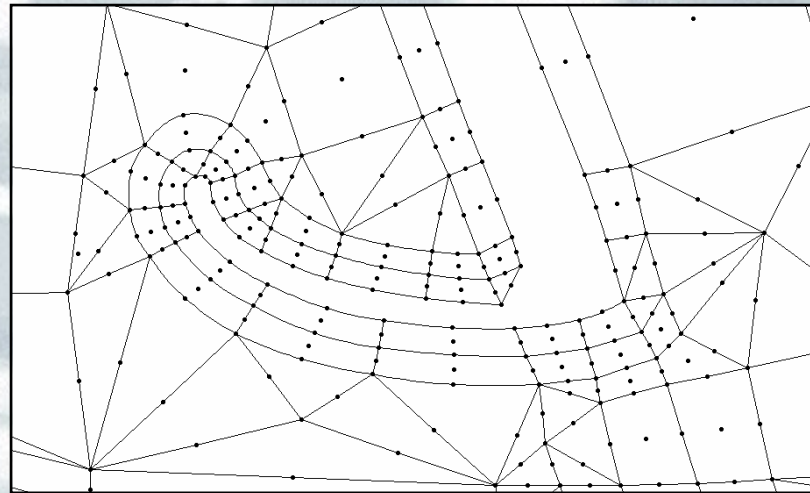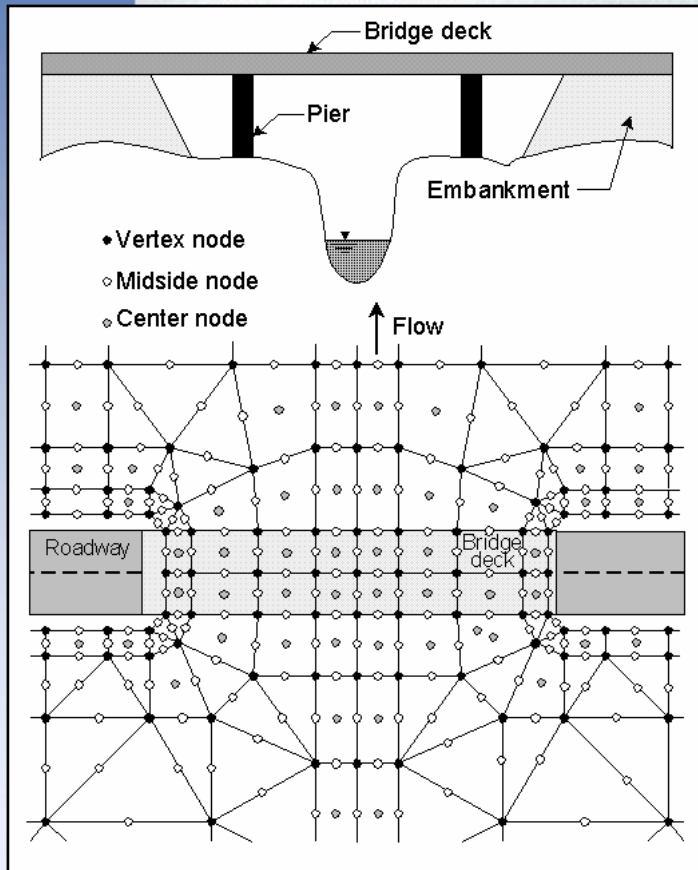Riprap basin depth: 0.0
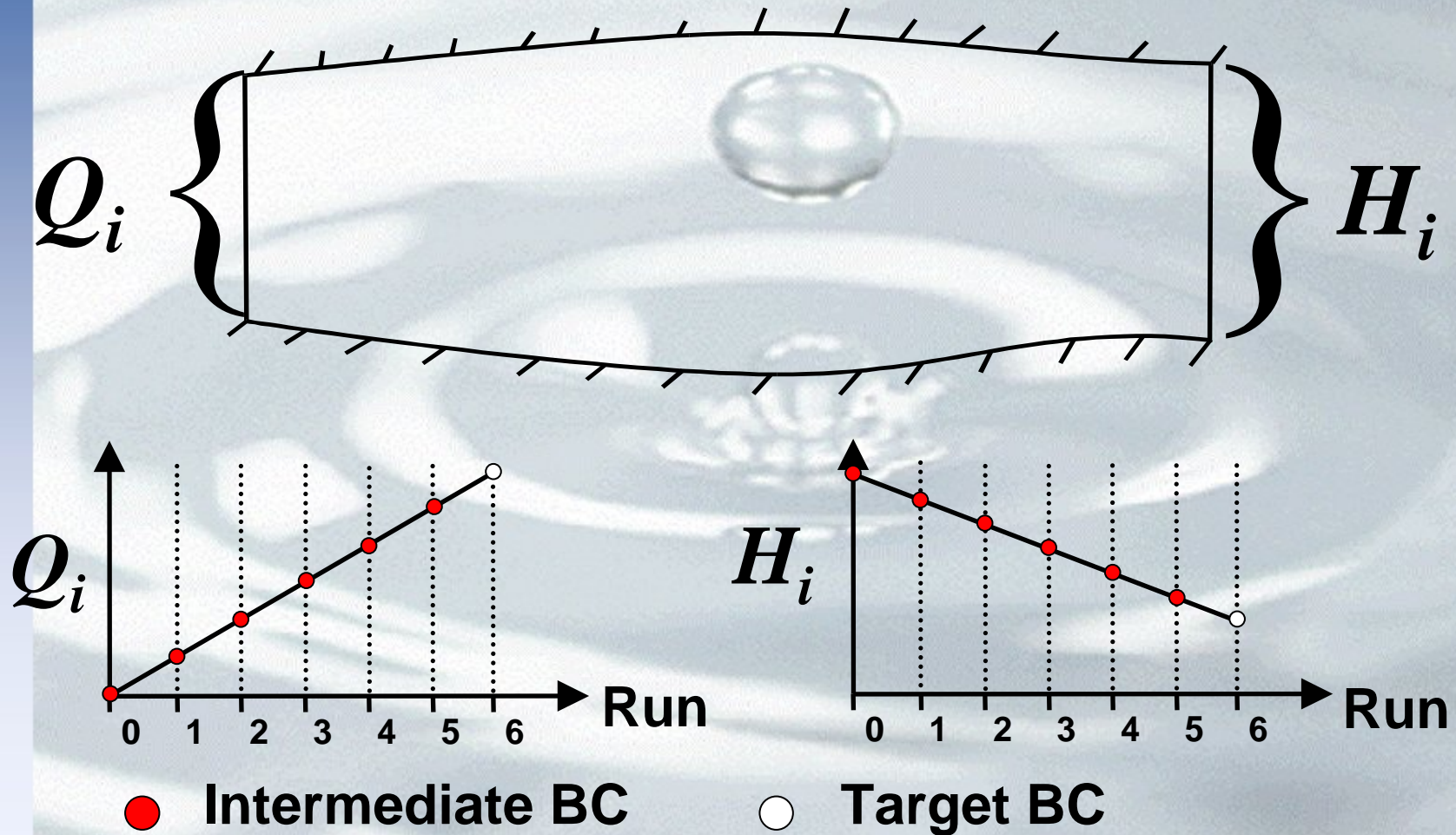
Help   OK   Delete   Cancel

2-Dimensional Flow Control
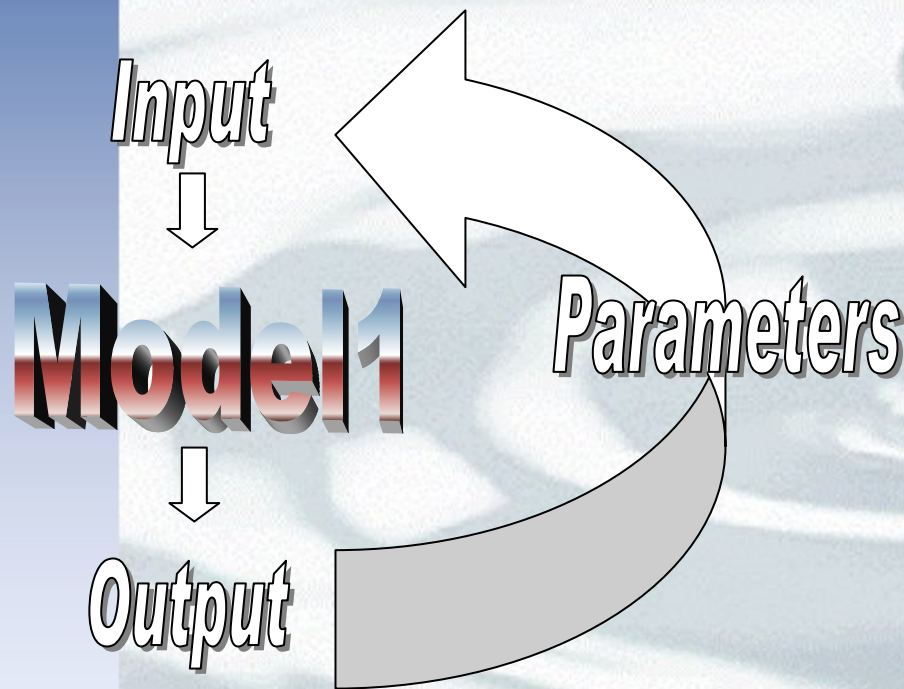
Form elements around the structure:

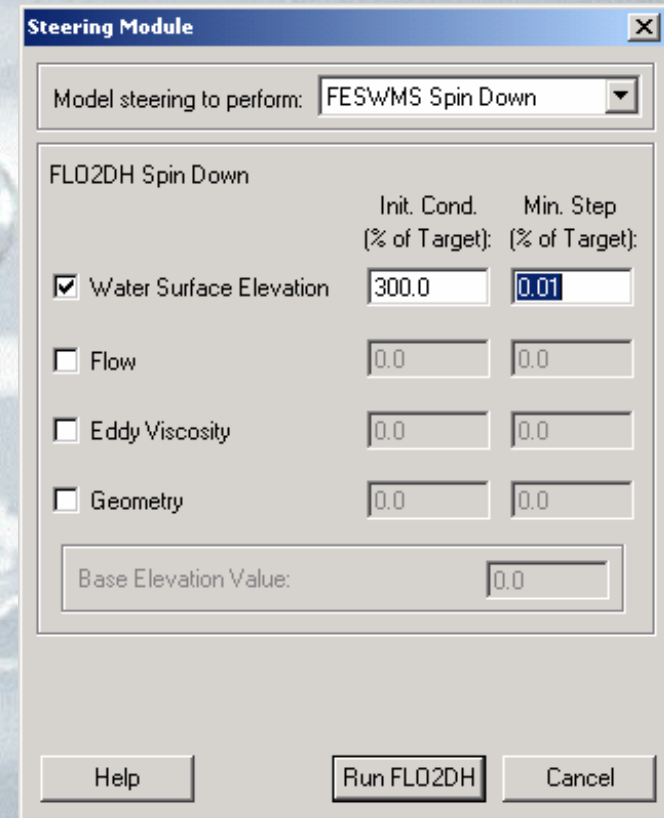- Embankments

- Guidebanks

Incremental Loading Strategy

Single Model Steering

Input

Model1

Output

Parameters

- Model Warm Up
  - ‣ Ramp Parameters
    - ▪ Flow rates
    - ▪ Water elevations
    - ▪ Eddy Viscosity
    - ▪ Geometry

- Multiple Cases
  - ‣ Range Parameters
    - ▪ Roughness
    - ▪ Viscosity
    - ▪ Particle Size

Automatic Incremental Loading

- Spin Down Channel
- Select Spin Down Option
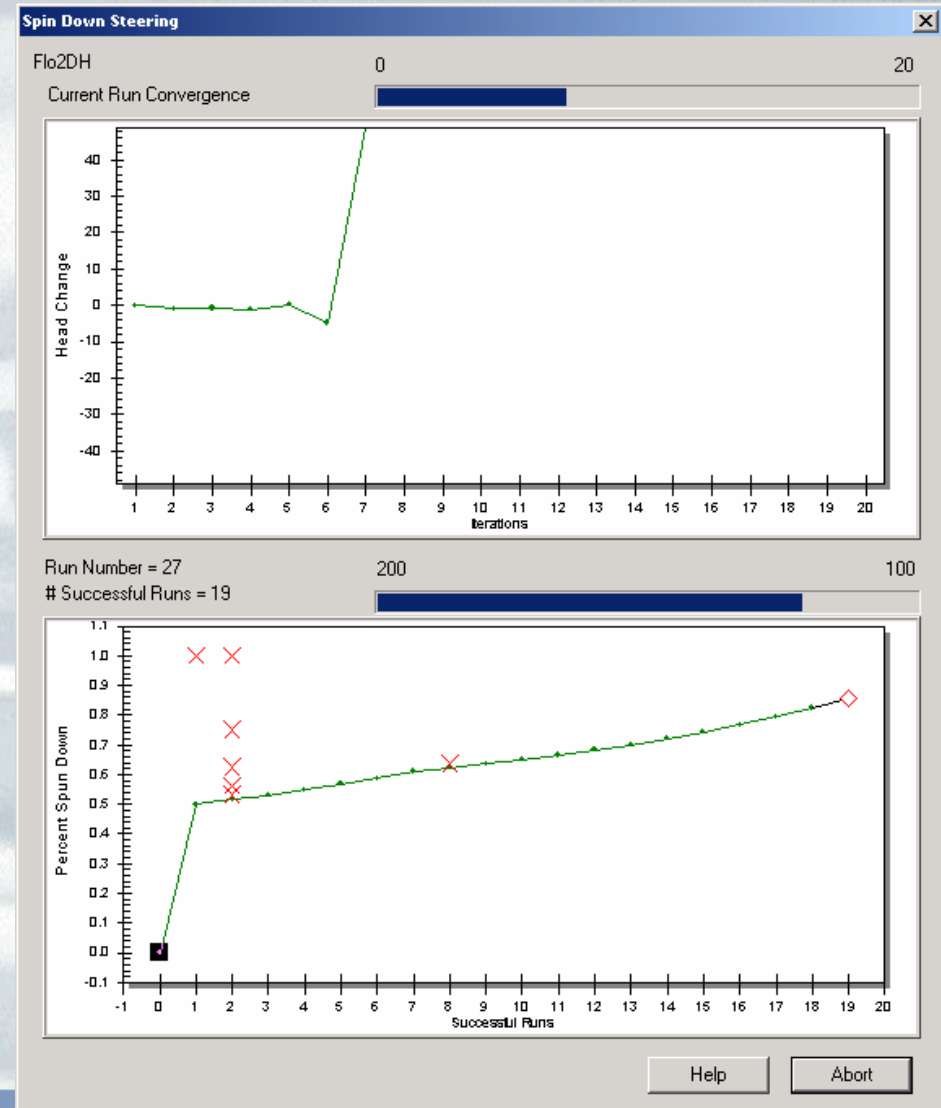- Initial Percentage
- Minimum Step

Successful Step

- Top Bar
  - ‣ Iteration Number
- Top Graph
  - ‣ Depth Convergence
- Run Numbers
- Bottom Bar
  - ‣ Percentage Complete
- Bottom Graph
  - ‣ Completion
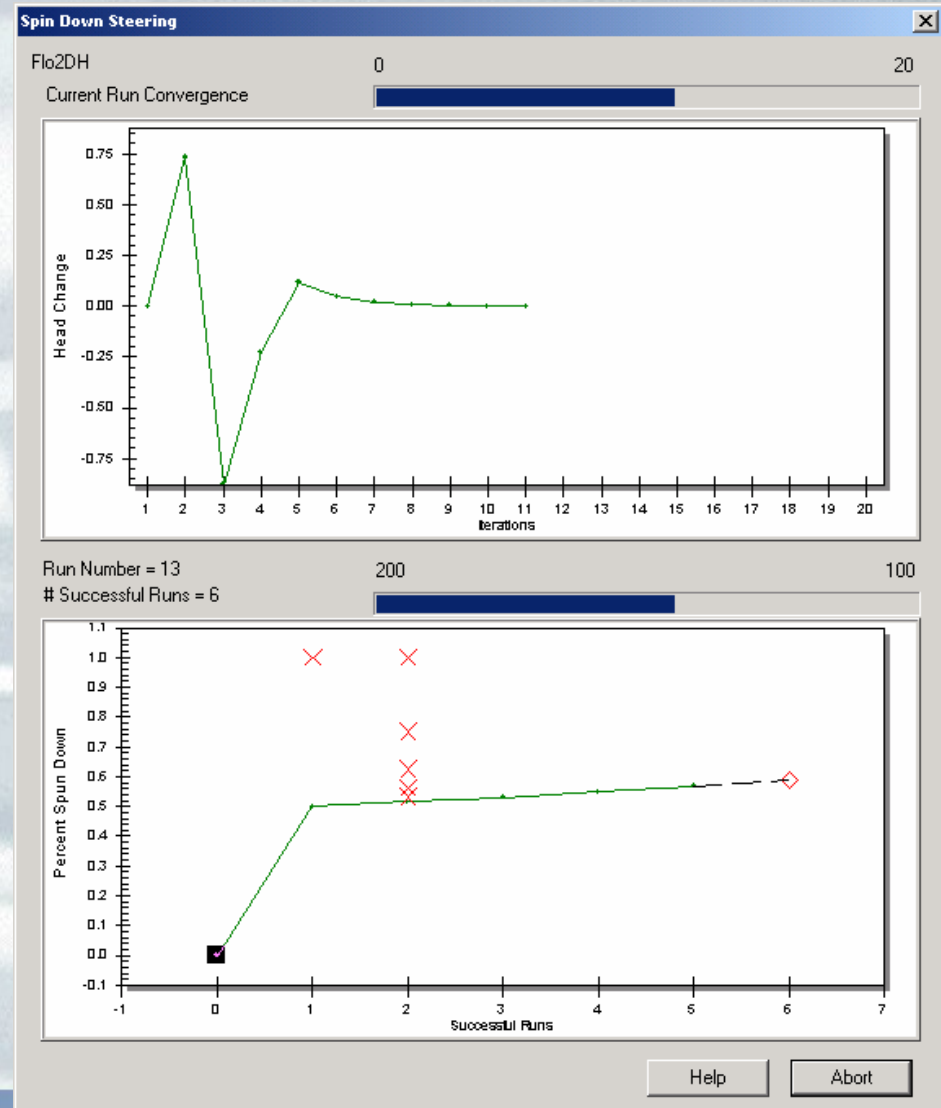
Unsuccessful Step

- Divergent Top Graph

- X added to Bottom Graph

- Smaller increment selected

SMS – 2D Numerical Models

- River Hydraulics/Water Quality
  - Flo2DH
  - RMA2/RMA4/SED2D-WES
- Coastal Circulation
  - ADCIRC
  - M2D
- Wave Analysis
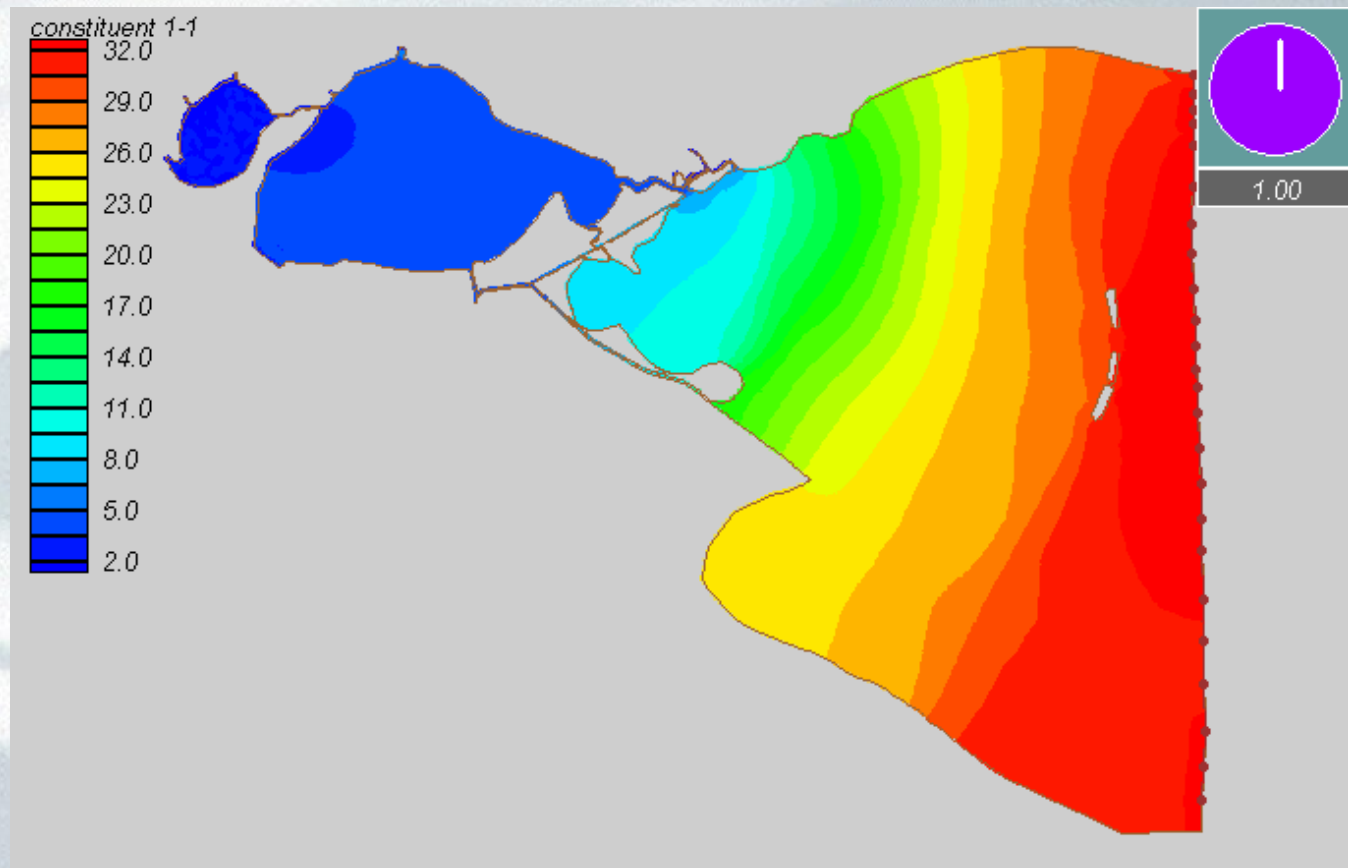 - STWAVE
  - CGWAVE

Applications in Estuaries/Bays

- Tidal Flooding
- Freshwater/Saltwater Interfaces
- Marsh Circulation
- Navigation Channels
- Water Quality – Detention
- Storm Modeling

Tidal Flooding – Saugus Bay

- Wetting and drying
- Flood control gate
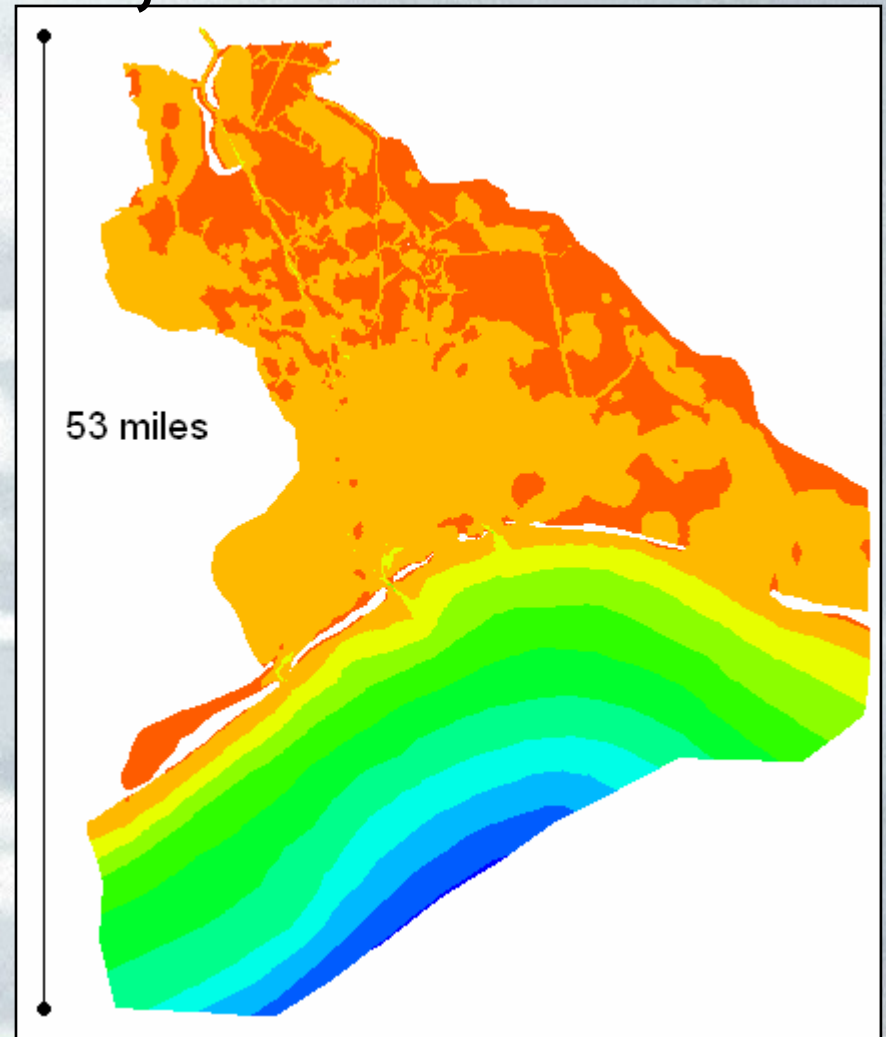- Guard against severe wave conditions (storm serge)
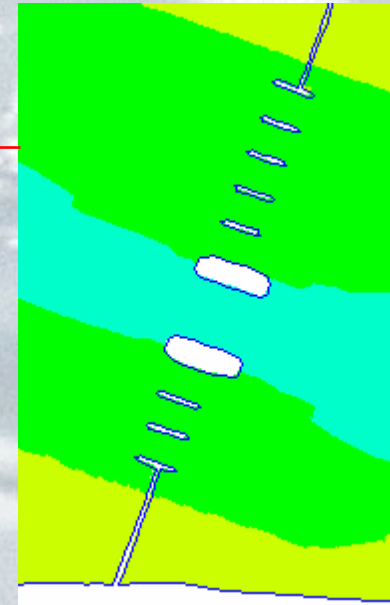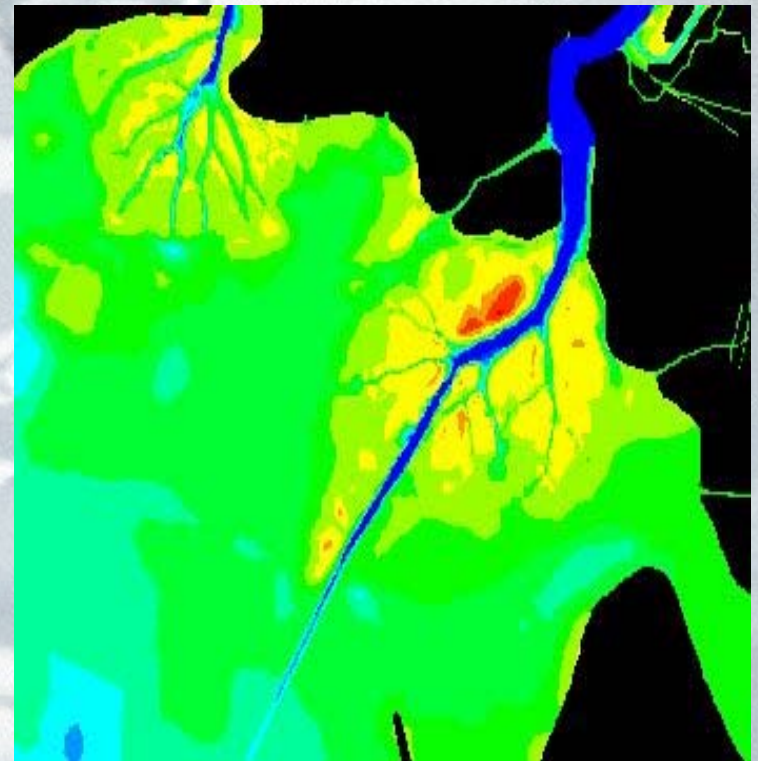
Salinity Intrusion –
Lake Ponchutrain - Louisianna

Freshwater Discharge – Barataria Basin, Louisiana

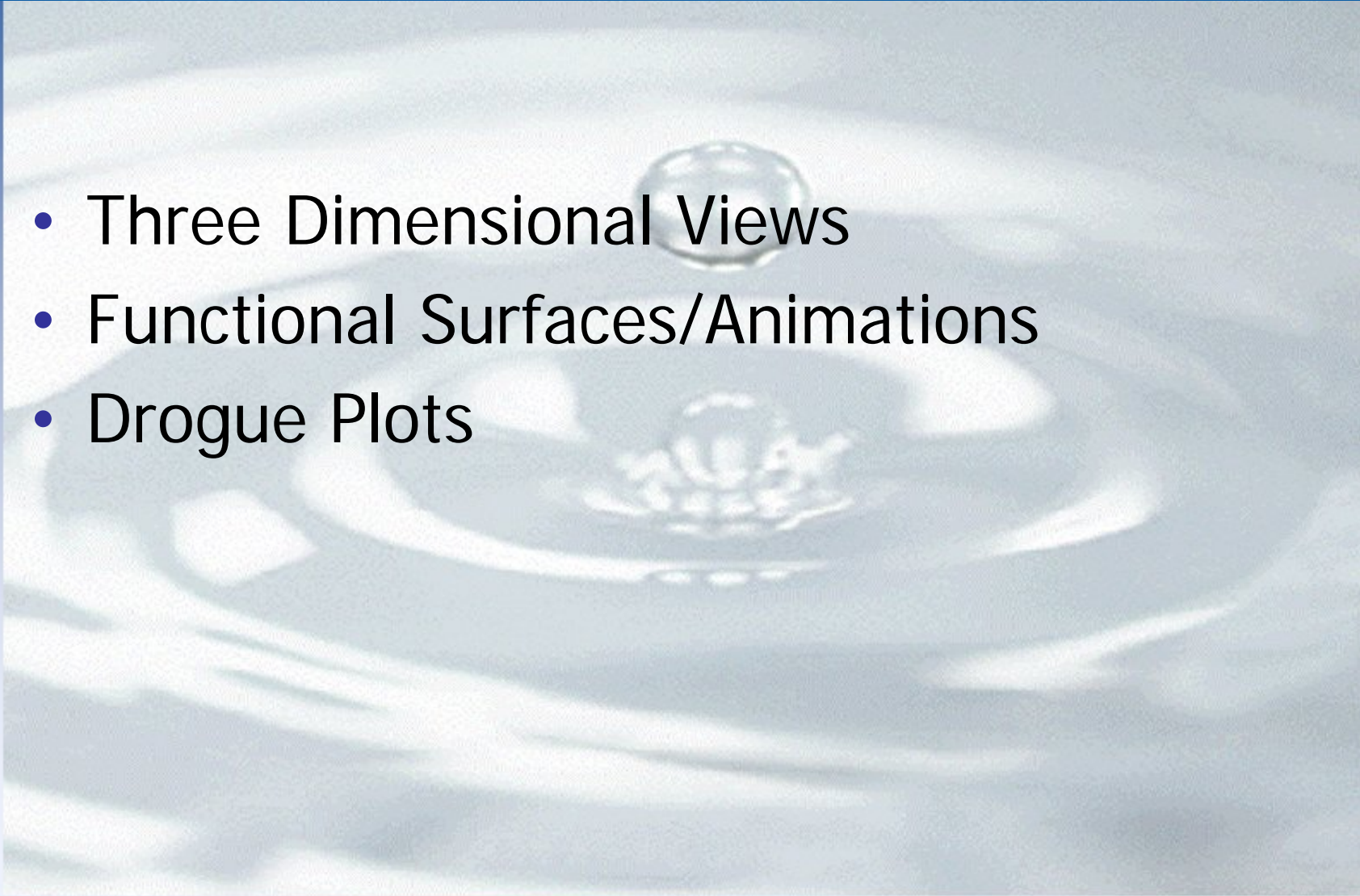Water Quality Issues

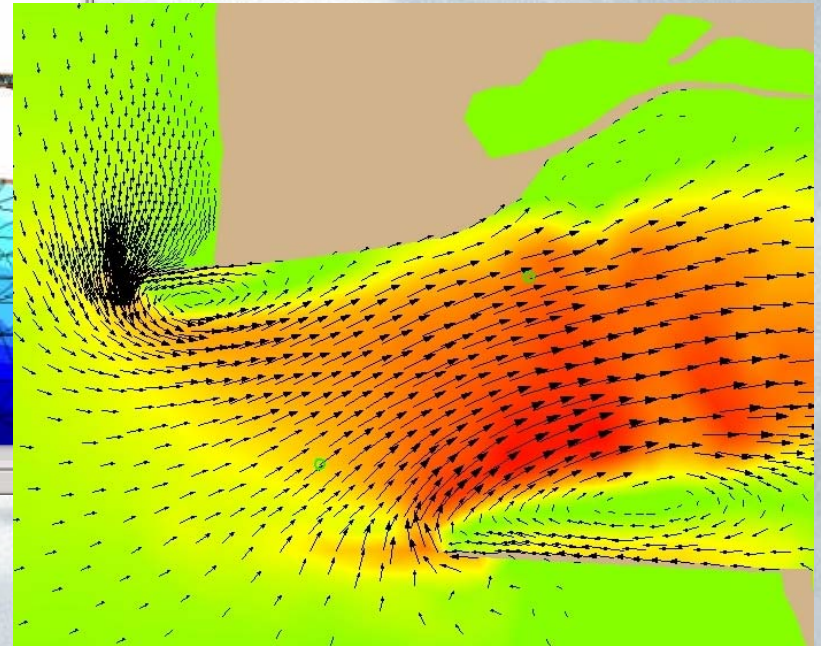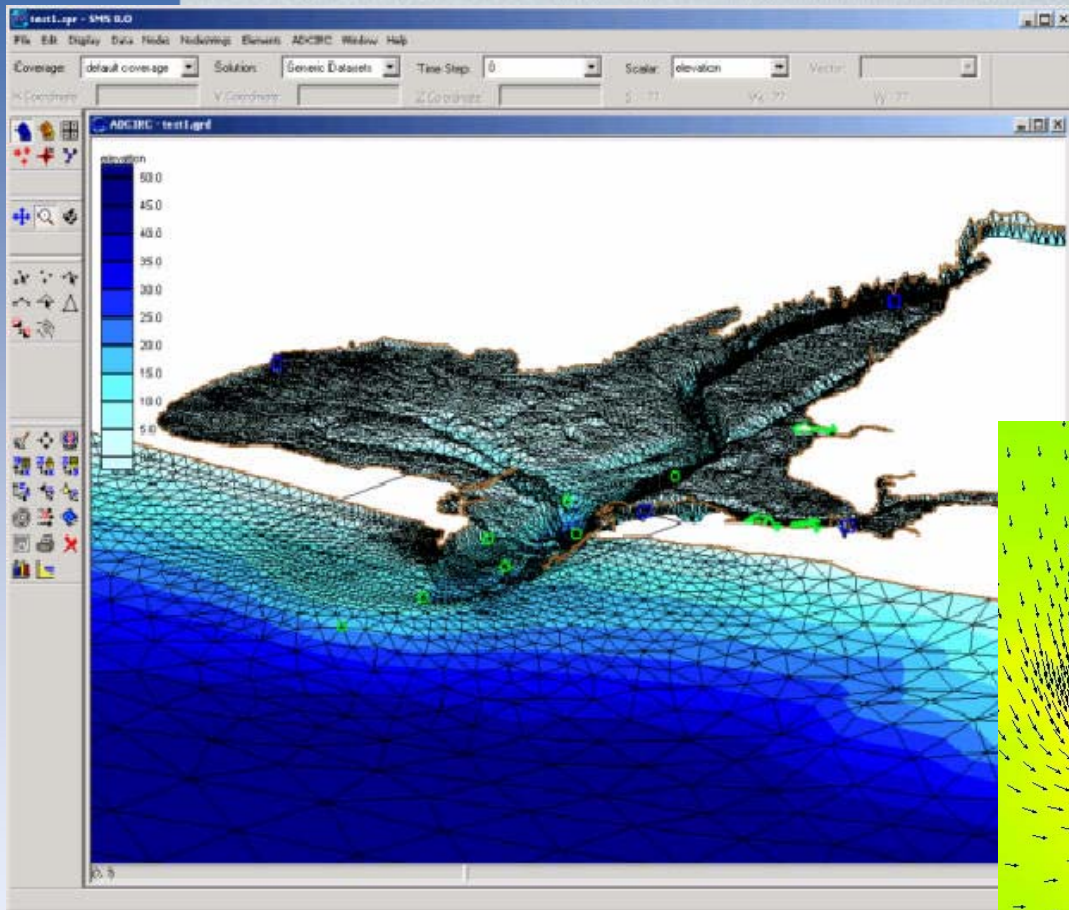53 miles

Marsh Circulation– Atchafalaya Bay Delta
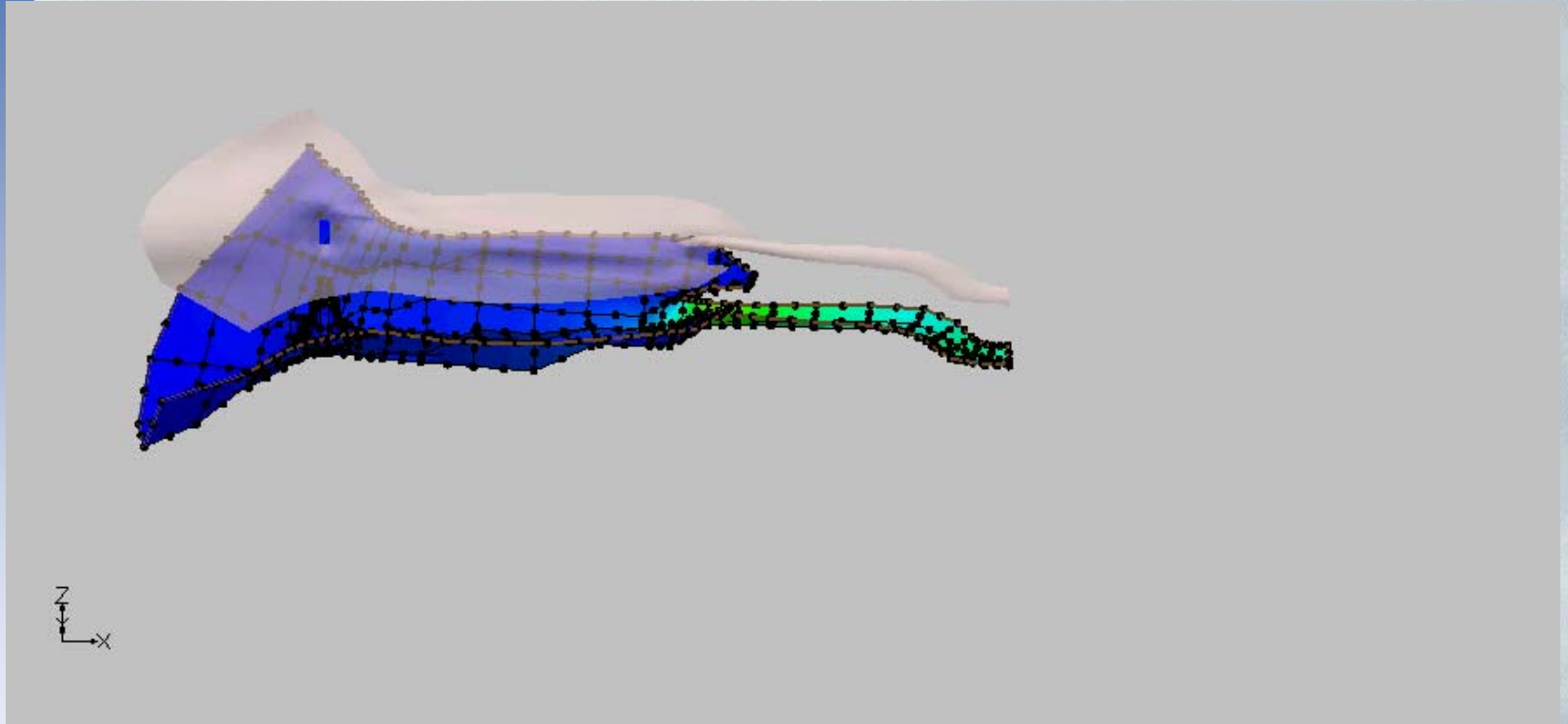
New Visualization

- Three Dimensional Views
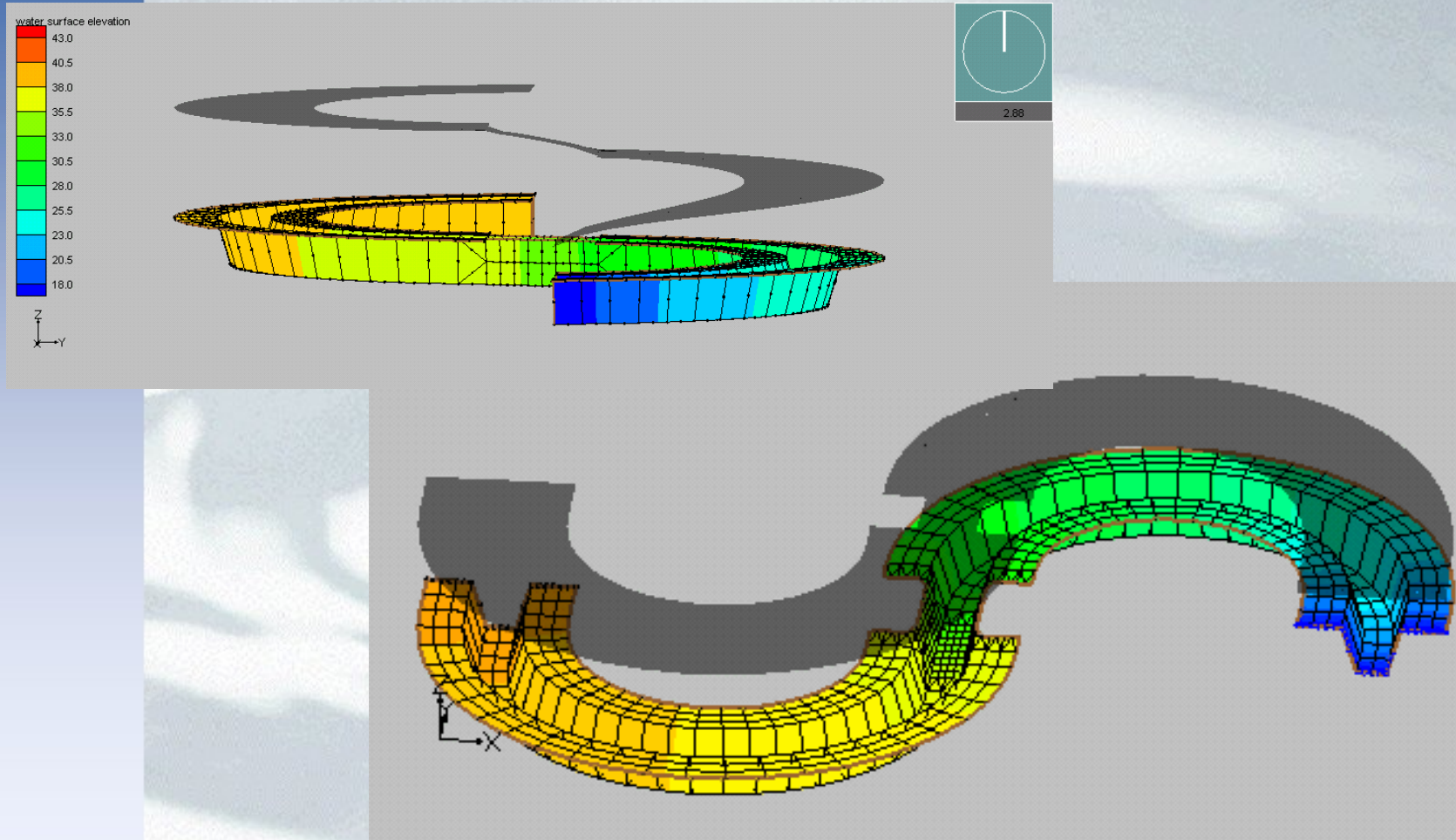- Functional Surfaces/Animations
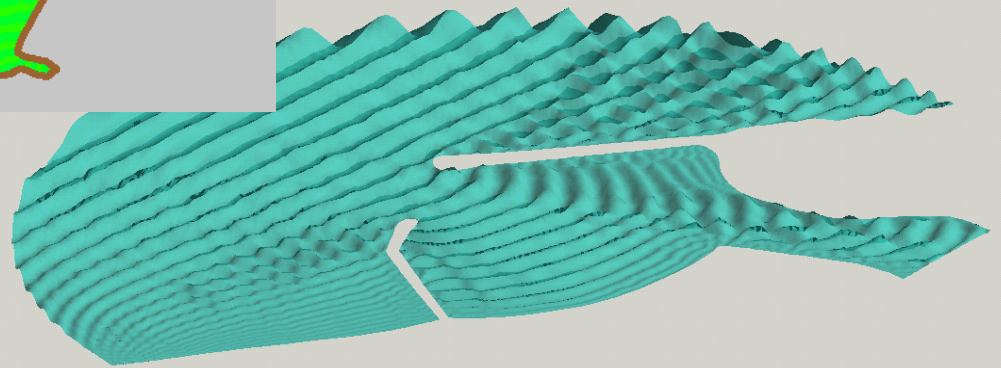- Drogue Plots

3-Dimensional View
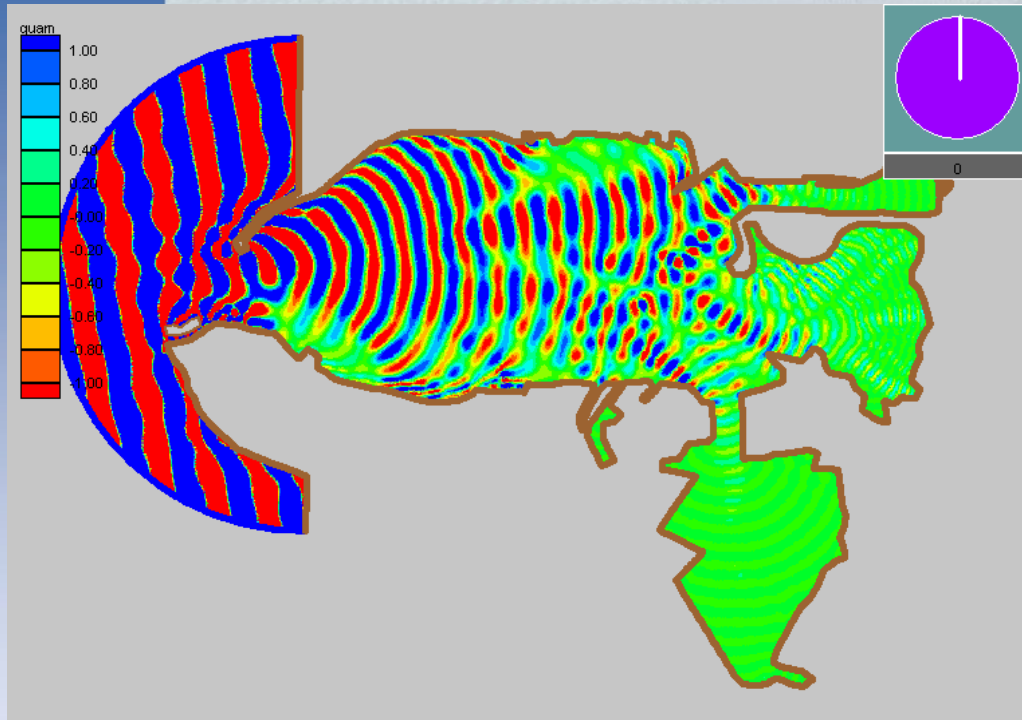
Animation of View Location
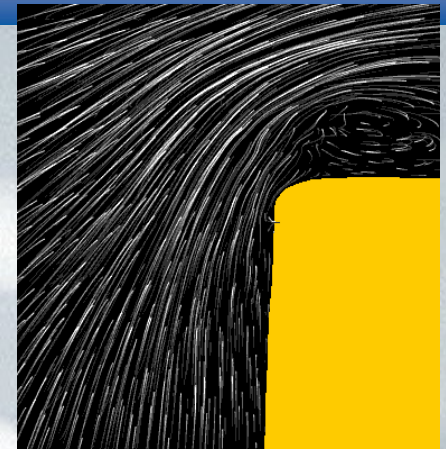
Animated Water Surface
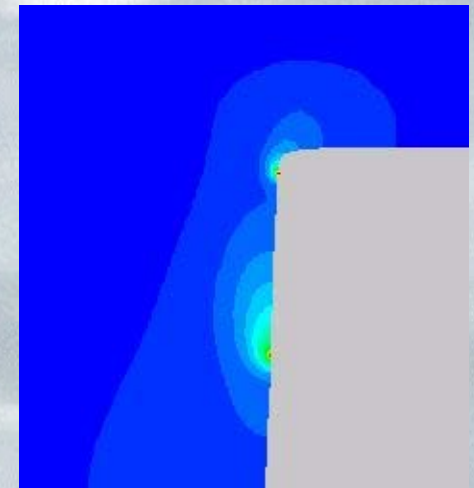
Drogue Plots

Other Applications

Theoretical Applications

- Design Alternatives
- Flumes
- Artificial Conditions
- Sensitivity

Using models to Examine Effects of Outlet Weirs from a Confined Disposal Facility (CDF)

Flow Trace at Ebb Tide

Turbidity Plume at Ebb Tide

Distribution

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  - ‣ Basic Contact Information
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  - ‣ Submit

The End

- Questions?